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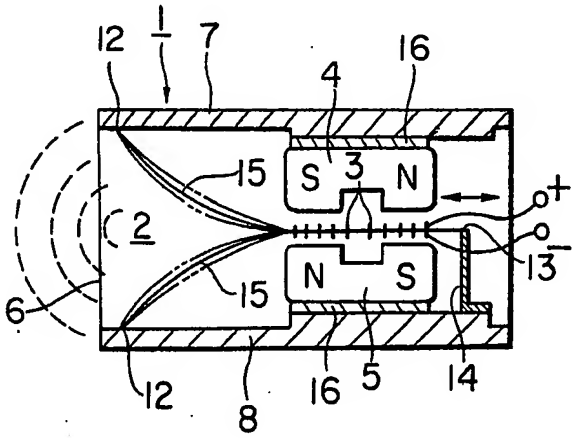
(54) Electroacoustic transducer.

(57) This electroacoustic transducer comprising a casing (1) having an opening portion; a sheet diaphragm (2) disposed in said casing and extending from said opening portion side to its opposite side, in which one end (12) thereof is formed as a fixed end and fixed in the casing, the other end (13) thereof being formed as a free end while being floatingly supported in the casing. A curved portion (15) is formed in the middle of the fixed and free ends and a coil (3) is provided in the vicinity of the free end. Permanent magnets (4, 5) are arranged opposite relative to the coil of this diaphragm in the casing.



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DESCRIPTION

T I T L E :

" ELECTROACOUSTIC TRANSDUCER ".

BACKGROUND OF THE INVENTION.

This invention relates to an electro-acoustic transducer for use in a full range speaker for audio, a twitter speaker and other normal speakers, a handset for telephone, a headphone, microphone units and the like.

As one typical example of the electro-acoustic transducers there is usually known a speaker comprising a voice coil attached to a top end portion opposite to a front opening portion of a corn-shaped diaphragm and an electromagnetic driving section disposed so as to make a magnetic circuit at fine gaps in said voice coil wherein when a voice signal is sent to said voice coil, the voice coil is driven vertically in concert therewith and said corn-shaped diaphragm emits a sound output.

However, the thus constructed speaker is defective in that since the diaphragm per se is corn-shaped the unit inevitably gets large-sized and thick as a whole, further it is inferior in vibration-proof, and still further the diaphragm has a tendency of vibrating sectionally in a high pitched tone area, whereby

voice can not be reproduced with high fidelity.

The inventor of this invention has proposed the electroacoustic transducer illustrated in Fig. 1 as the electroacoustic transducer capable of eliminating the aforegoing defects. This prior art electroacoustic transducer comprises printing coils 23 on both end portions and floatingly supports, a convexly curved sheet diaphragm 22 by means of permanent magnets 24 and 25 disposed adjacent to each coil 23 in a casing 21, wherein when an electric current is applied to each coil 23 an electromagnetic force exerted on each coil 23 displaces both end portions of said diaphragm along its surface, thereby causing its central curved portion to displace to dotted places in the perpendicular direction relative to the diaphragm surface for producing a sound, and this sound is emitted to the outside. This electroacoustic transducer, designed as above, is capable of doubling the amount of displacement of the central curved portion of the diaphragm 22 as compared to that of each end portion thereof. Therefore, this electroacoustic transducer is advantageous in that despite use of a plane drive, it has a wide directivity, it can be made thin as a whole and further it has a superiority in producing a low sound.

On the other hand, said electroacoustic

transducer is disadvantageous in that since electromagnetic driving sections must be provided at both end portions of the diaphragm 22, there is required a wide printing area for the coil 23, the number of permanent magnets needed is four and thus a number of parts are required, whereby it is difficult to make it small-sized as a whole and the use is limited thereby.

SUMMARY OF THE INVENTION.

It is an object of this invention to provide an electroacoustic transducer capable of eliminating the inherent disadvantages in the above mentioned prior art electroacoustic transducer and exhibiting its advantages as they are, in other words an electroacoustic transducer that has a small number of parts, is easily small-sized as a whole and is applicable for a wide range of applications.

According to this invention, said object can be achieved by providing an electroacoustic transducer including a casing having an opening portion; a sheet diaphragm disposed in said casing and extending from said opening portion side to its opposite side, in which one end thereof is formed as a fixed end and fixed in the casing, the other end thereof is formed as a free end supported floatingly in the casing, a curved portion is formed in the middle of the fixed and

free ends and a coil is provided in the vicinity of the free end; and permanent magnets arranged opposite relative to the coil of this diaphragm in the casing.

It is another object of this invention to provide an electroacoustic transducer that can produce a cylindrical plane wave type sound capable of releasing a listener from being tired with hearing by means of a sheet diaphragm, can attain an acoustic efficiency similar to that of the usual horn speaker in spite of being made thin as a whole due to the capability of producing such a cylindrical plane wave, and is especially suitable as a speaker for car radio and the like.

According to this invention, said object can be achieved by providing an electroacoustic transducer which comprises arranging a pair of sheet diaphragms with curved portions symmetrically in a casing, overlapping the portions adjacent to their rear edge portions into one layer, forming one of the front and rear edges into a fixed end and the other into a free end, providing a coil in the vicinity of said free end, and disposing permanent magnets at the positions opposite to coils attached to the inner surfaces of upper and lower walls of the casing.

It is a further object of this invention to provide an electroacoustic transducer designed so

that a sound produced on the side opposite to an opening portion of a casing by a diaphragm is allowed to leak from between both side edges of the diaphragm and the inner surfaces of both side walls of the casing so as to prevent a sound emitted toward the opening portion side from undergoing interference therefrom, whereby it can reproduce an espacially low-ranged (about 150 Hz) sound readily and further it, especially when used as a car radio speaker or the like, has no fear of being hindered by noises outside the car.

According to this invention, said object can be achieved by providing an electroacoustic transducer which comprises connecting both side edges of a curved plate of a diaphragm to inner surfaces of both side walls of a casing by means of a flexible material-made free edge member.

BRIEF DESCRIPTION OF THE DRAWING.

Fig. 1 is a longitudinal sectional front view of the prior art electroacoustic transducer which the inventor of this invention has proposed previously.

Fig. 2 is a front view of a first embodiment of the electroacoustic transducer according to this invention.

Fig. 3 is a longitudinal sectional side view taken on line 3-3 according to the direction of the arrow of Fig. 2.

Fig. 4 is a slant view illustrating the partially cutaway inside of the electroacoustic transducer of Fig. 2 wherein the cutaway portion is indicated with a chain line.

Fig. 5 is a plan view of the diaphragm of the electroacoustic transducer illustrated in Fig. 2.

Fig. 6 is a partially enlarged sectional view taken on line 6-6 according to the direction of the arrow of Fig. 2.

Fig. 7 is a schematic side view of the main portion of a second embodiment of the electroacoustic transducer according to this invention.

DETAILED DESCRIPTION OF THE INVENTION.

Figs. 2 to 5 illustrate a first embodiment of the electroacoustic transducer according to this invention respectively.

In these figures, reference numeral 1 denotes a casing including upper and lower walls 7 and 8, side walls 9 and 10; and an opening portion 6 at the front edge, wherein a pair of upper and lower diaphragms 2 are disposed symmetrically.

As is best evident from Fig. 5, each diaphragm 2 comprises a printed plate having thereon formed a rectangular and circular coil 3 by applying a copper foil on about the half (the right half in Fig. 5) of the surface of a properly flexible synthetic resin

sheet 11 and subjecting the same to chemical etching. This coil 3 may be formed on the surface of sheet 11 in another way than the above mentioned.

In the case of the diaphragm 2 as illustrated in Fig. 2, its front edge 12 opposite to the coil 3 is fixed in the inner surface of each of the upper and lower walls 7 and 8 of the casing 1 in the vicinity of the opening portion 6. On the other hand, the portions which contain coil 3 and which are adjacent to the rear edges overlap each other so that the coils 3 of both diaphragms 2 are connected to have a plus terminal and a minus terminal in common. The thus overlapped rear edge 13 is supported movably in the horizontal direction (the right and left directions in Fig. 3) by a holding member 14 erected on the inner surface of the lower wall 8. The diaphragm 2 has curved portions 15 formed in the middle of front edges 12 and the coil 3, and consequently, as can be seen from Fig. 3, takes the shape of the longitudinal sectional surface of a horn speaker viewed from the side.

The inner surfaces of the upper and lower walls 7 and 8 of the casing 1 are provided with permanent magnets 4 and 5 at places opposite to the coil 3 respectively, wherein poles S and N of the permanent magnet 4 are devised to confront poles N and S of the permanent magnet 5 and both minus terminals of the

coil 3 are common and connected to a signal source (not shown) such as an amplifier or the like. The permanent magnets 4 and 5 are surrounded with a magnetic material 16 such as iron or the like.

The gaps formed between both side edges 17 of curved portions 15 of the diaphragm 2 and both side walls 9 and 10 of casing 1 are closed by means of flexible free edges 18 as shown in detail in Fig. 6, wherein one side edge of the free edge 18 is connected with the side edge 17 of the diaphragm 2 and the other side edge thereof is connected with side walls 9 and 10.

The operation of this transducer will now be described hereinafter.

When an electric signal is impressed between the plus terminal and the minus terminal of coil 3, right and left directional forces (in Fig. 3) are generated in the coil 3 crossing a line of magnetic force present between permanent magnets 4 and 5 and consequently the rear edge 13 of the diaphragm 2 is moved as indicated by the arrow. This movement subjects the curved portion 15 to a vertically directional flexible deformation as indicated by chain lines in Fig. 3 for vibrating the air present between both diaphragms 2 and emitting to the outside through the opening portion 6, whereby a sound corresponding to the electric signal can be produced.

In this case, this electroacoustic transducer, having a construction as described above, can double the amount of movement of the curved portion 15 in comparison with that of the coil 3, whereby a very satisfactory low-ranged sound reproduction can be obtained. Further, since there is no necessity of increasing the amount of movement of coil 3, the mounting area therefor may be decreased. Still further, since it is sufficient to dispose two permanent magnets 4 and 5 only at the places confronting this coil 3, the number of parts may be decreased with respect to the aforesaid prior art transducer which requires four permanent magnets. Accordingly, the electroacoustic transducer according to this invention can be markedly small-sized as a whole. The same is true of an electroacoustic transducer in which, unlike the said embodiment, not a pair but only one diaphragm 2 is provided and only one permanent magnet is also provided. That is, this electroacoustic transducer can be made more thick and small-sized than that disclosed in said embodiment.

By the way, the electroacoustic transducer according to said embodiment is advantageous in that owing to the provision of a pair of diaphragms 2 there can be obtained a cylindrical plane wave type sound that can release a listener from being tired with hearing as

compared with a spherical wave type one.

According to the said embodiment, furthermore, since both side edges 17 of the diaphragm 2 are connected with both side walls 9 and 10 by means of the free edge 18, the vibrating wave generated rearwards (to the right in Fig. 3) by the vibration of the diaphragm 2 is allowed to leak forward through the gaps between both side edges 17 of the diaphragm 2 and both side walls 9 and 10 of the casing 1 so that the normal vibrating wave may be released from the interference to be caused thereby, whereby sound reproduction can be effected correctly and readily up to the low range such as about 150 Hz and even when used as a car radio speaker the hindrance from noises outside of the car can be reduced.

Fig. 7 illustrates a second embodiment of the electroacoustic transducer according to this invention. This embodiment is different from the first embodiment in that since a front edge 12' of a diaphragm 2' is formed in a free end and a rear edge 13' thereof is formed in a fixed end, a coil 3 is provided in the vicinity of the front edge 12', permanent magnets 4' and 5' are disposed on the inner surfaces of upper and lower walls of a casing 1, and the rear edge 13' is fixed by means of a holding member 14'.

In view of the fact that the electroacoustic transducing operation disclosed in the second

embodiment is just the same as that disclosed in the first embodiment and there is no difference in the resultant advantages therebetween, detailed explanation on the former will be omitted as being needless.

- C L A I M S -

1. An electroacoustic transducer characterized in that it comprises a casing (1) having an opening portion (6), a sheet diaphragm (2) disposed in said casing and extending from sais opening portion side to its opposite side, in which one end thereof is formed as a fixed end (12) and fixed in the casing, the other end thereof being formed as a free end (13) and is floatingly supported in the casing, in that a curved portion (15) is formed in the middle of the fixed and free ends and a coil (3) is provided in the vicinity of the free end; and in that permanent magnets (4,5) are arranged opposite relative to the coil of the diaphragm in the casing.

2. The electroacoustic transducer according to claim 1, characterized in that the fixed end (12) of the diaphragm (2) is disposed in the vicinity of the opening portion (6) of the casing (1) and the free end (13) thereof is disposed opposite to the fixed end.

3. The electroacoustic transducer according to claim 2, characterized in that the free end (12') of the diaphragm (2') is disposed in the vicinity of the opening of the casing (1) and the fixed end (13') is disposed opposite to the free end.

4. The electroacoustic transducer

according to claim 1, characterized in that the sheet diaphragm (2) comprises a pair of upper and lower diaphragm elements disposed symmetrically to each other and their portions adjacent to rear edges (14) are overlapped.

5. The electroacoustic transducer according to any one of the claims 1-4, characterized in that both side edges of the curved portion (15) of the diaphragm (2,2') are connected to the inner surfaces of both side walls of the casing (1) by means of a free edge respectively.

6. The electroacoustic transducer according to claim 4, characterized in that the front edges (12) of the pair of diaphragms (2) are fixed in the inner surfaces of upper and lower walls adjacent to the opening portion (6) of the casing (1), a coil (3) is provided on the upper and lower surfaces of a layer formed adjacent to the rear edge portions of the diaphragms; permanent magnets (4,5) are arranged on the inner surfaces of upper and lower walls of the casing oppositely relative to this coil; and the rear edges (13) thereof are supported floatingly by means of a holding member (14) provided in the casing.

7. The electroacoustic transducer according to claim 4, characterized in that the front edges (12') of the pair of diaphragms (15) are supported floatingly by means of a holding member provided on the

inner surfaces of upper and lower walls adjacent to the opening portion of the casing (1); a coil (3) is provided on a surface confronting the inner surfaces of upper and lower walls of the casing in the vicinity of the front edges of the diaphragms; permanent magnets (4',5') are arranged on the inner surfaces of upper and lower walls of the casing oppositely relative to this coil; and the rear edges thereof are fixed in a fixing member provided in the casing respectively.

8. The electroacoustic transducer according to claim 6, characterized in that both side edges of the curved portion of each diaphragm (2) are connected to the inner surfaces of both side walls of the casing (1) by means of a free edge comprising a flexible plate material (18).

9. The electroacoustic transducer according to claim 7, characterized in that both side edges of the curved portion of each diaphragm (2) are connected to the inner surfaces of both side walls of the casing (1) by means of a free edge comprising a flexible material.

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FIG. 1

PRIOR ART

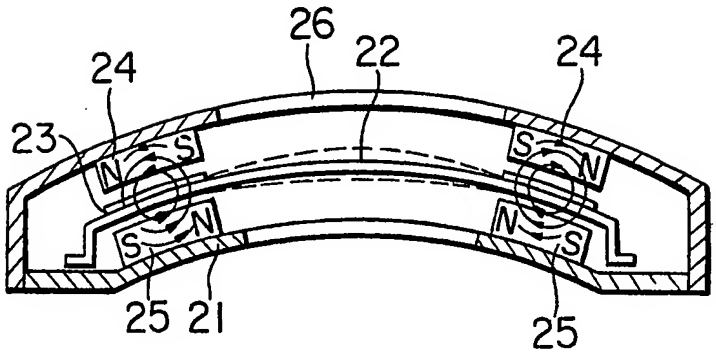

FIG. 2

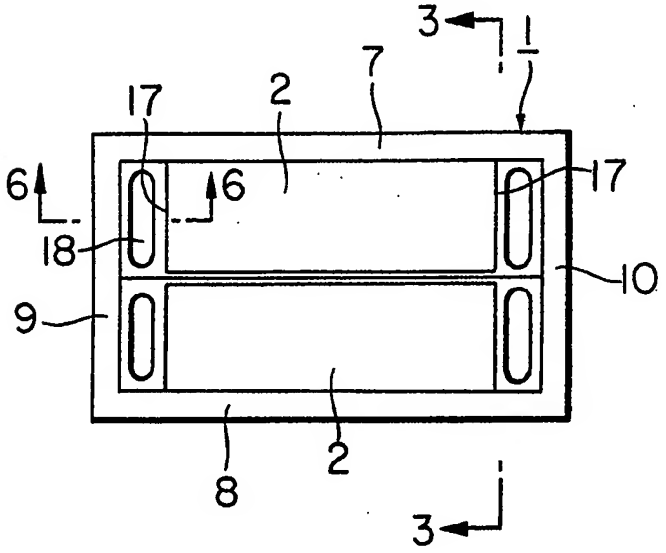

FIG. 3

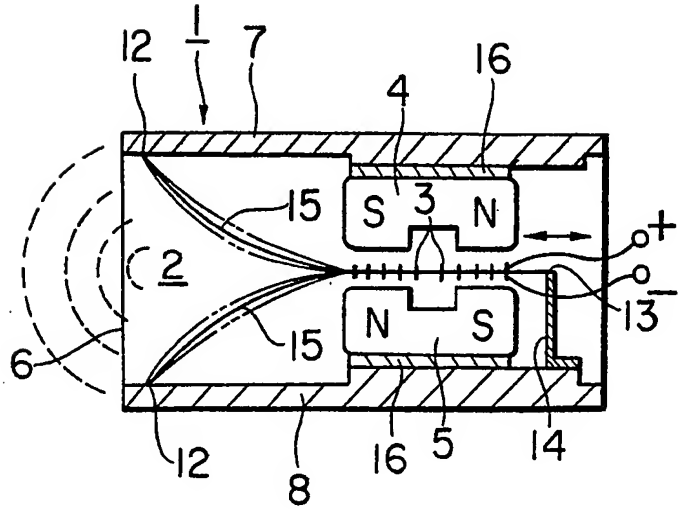

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FIG. 4

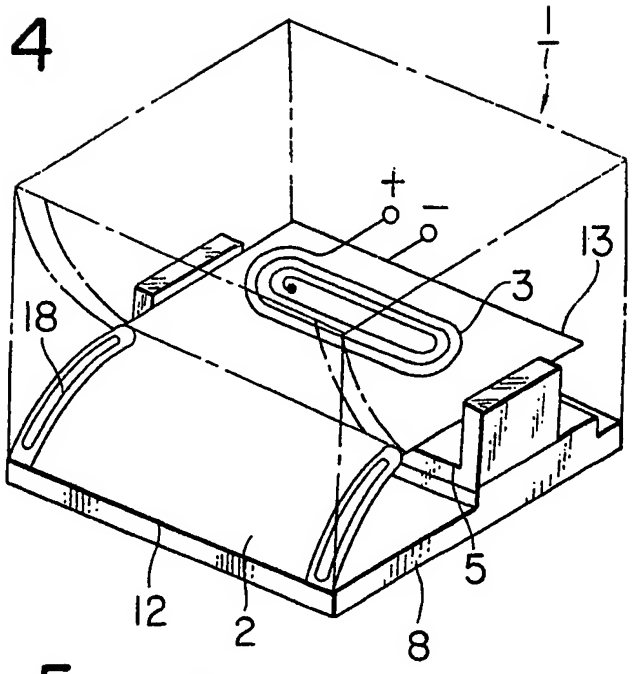

FIG. 5

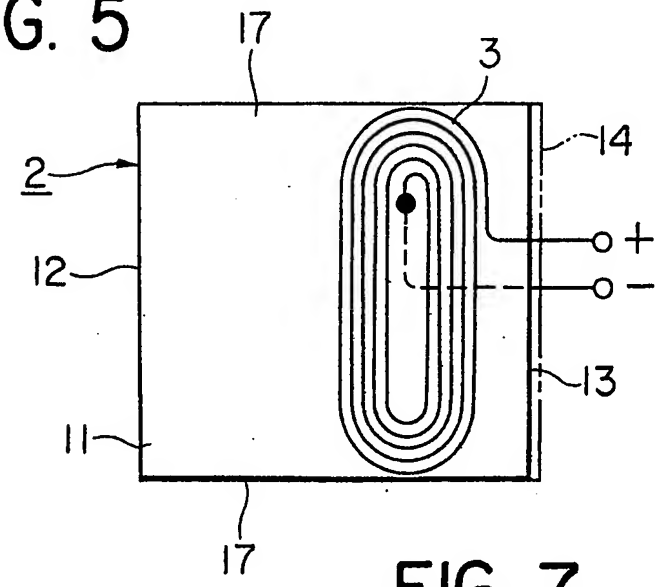

FIG. 6

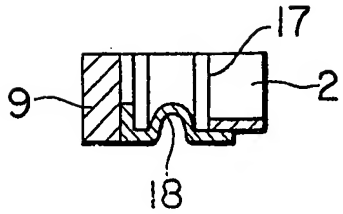

FIG. 7